AERONAUTICAL CHARTING FORUM
Instrument Procedures Group
April 28-29, 2003
HISTORY RECORD

FAA Control # 03-01-247

Subject: Holding Pattern Criteria Selection

Background/Discussion: FAA Order 7130.3A, "Holding Pattern Criteria," contains the containment criteria for all FAA holding patterns. The criteria assumptions contained in this order are predicated on a March 31, 1964 order, FAA Handbook AT P 7130.8, "Development of Holding Pattern Criteria and Procedures." 31 holding pattern templates were developed to fit over 100 different combinations of indicated airspeed (IAS), altitude, and distance from facility in the case of ground-based navaids. Averaged seasonal winds aloft were part of this extensive 1964 evaluation. An important fact is that the width and length each of the 31 templates are intrinsically linked. Thus, if you select a smaller pattern to conserve length, you also reduce the protected airspace for the dead reckoning entry and outbound flight.

In what appears to be a 1997 amendment to FAAO 7130.3A, a section was added to provide for the selection of GPS (RNAV) holding patterns. This GPS selection process reduces the pattern size by two to five pattern sizes, for a given altitude and IAS. An example is attached that shows holding at the missed approach fix for the KSUN RNAV (GPS) Rwy 31 SIAP. The selection process requires that the pattern for 230 knots, IAS, and 10,000 feet, be selected for this fix. If the non-GPS, holding-at-facility selection table were used, Pattern #9 would be used. But, because the GPS selection process was used, Pattern #7 would be used. A simulation with a 60 knot wind from the north was used and an IAS of 230 knots was used, which resulted in the ground track shown both in Figures 2 and 3. The track shown is not the entry turn, rather it is the first turn to enter a complete circuit of the holding pattern (the first turn subsequent to the entry turn). As you can see, containment is nearly breached in the DR outbound turn.

It appears that the selection process for GPS holding patterns was reduced because distance holding can be used all of the time instead of timed holding. Although reduction in the length of a GPS holding pattern is probably justified, a reduction in the width of the pattern is not. The wind, IAS, and turning performance assumptions made in the 1964 study are still valid (and required) for today's GPS flight operations until such time as the entire holding pattern is a positive course guidance (PCG) procedure, and predicated upon valid, updated studies of winds aloft, and turning performance in conditions of PCG. Most, if not all, TSO-C129A avionics devices require DR flight for both entry and outbound flight in the holding pattern. And, even the high-end LNAV platforms that employ a PCG scheme throughout the pattern probably are not reconciled to Order 7130.3A pattern containment areas.

Further examples of unjustified pattern size reduction for GPS are as follows: 10,000 feet, 265 knots—non-GPS selection results in Pattern #11; GPS selection results in Pattern #8. 14,000 feet, 310 knots—non GPS selection results in Pattern # 18; GPS selection results in Pattern #14. See Figures 4 and 5. (These are pattern sizes used for climb-in-hold "CIH" extraction patterns.)

The 1964 Order 7130.8 is available on my web site as an Acrobat file. Appendix 2, page 1 shows the intrinsic relationship between pattern width and length:

http://www.wallyroberts.com/hpcriteria

A related issue is the ambiguity about when either 265 or 310 knot holding is authorized for CIH purposes. Although there is some general AIM guidance about when 310 knots is authorized, the pilot has no way of knowing where it is safe to climb at speeds greater than level flight holding speeds.

Finally, the leg lengths that the GPS selection process specifies are often unflyable in adverse wind aloft conditions. Although 4-mile legs are shown at PRESN waypoint, 6-miles should have been charted. But, even 6 miles is an unflyable leg length under the wind conditions simulated for Figures 2 and 3.

Recommendations: That the GPS selection table in FAAO 7130.3A immediately be brought into conformance with the hold-at-facility selection table for non-GPS holding. Further, that charted leg lengths mileage values be of sufficient length to be flyable in jet aircraft, which operate at maximum level-flight holding speed, and with the assumed maximum adverse winds aloft existing during the hold. Further, the values to be charted must not be greater than the leg lengths that are provided for non-radar, timed holding.

In the future, PCG holding criteria should be developed, but only after all IFR-certified RNAV/GPS avionics are capable of PCG flight throughout the entry and entire circuit of the pattern, and in conformance with the containment criteria.

Although some efforts are already underway to clarify and chart CIH authorizations, that effort should be expedited.

Comments: This recommendation affects FAAOs 7130.3A, 8260.19C, the Aeronautical Information Manual (AIM), and IACC charting specifications.

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Date: April 4, 2003

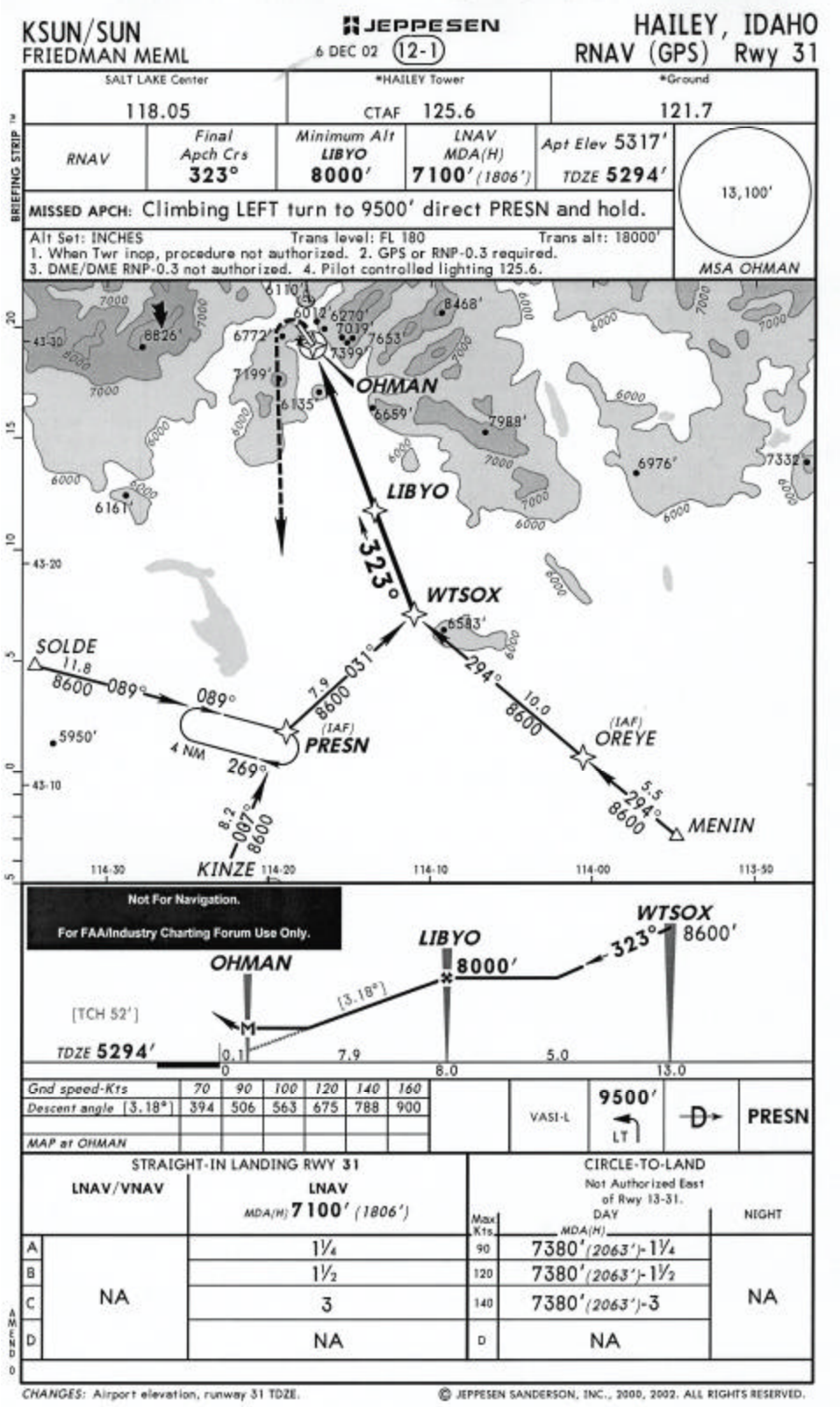

Figure 1 – Jeppesen Chart – KSUN RNAV 31

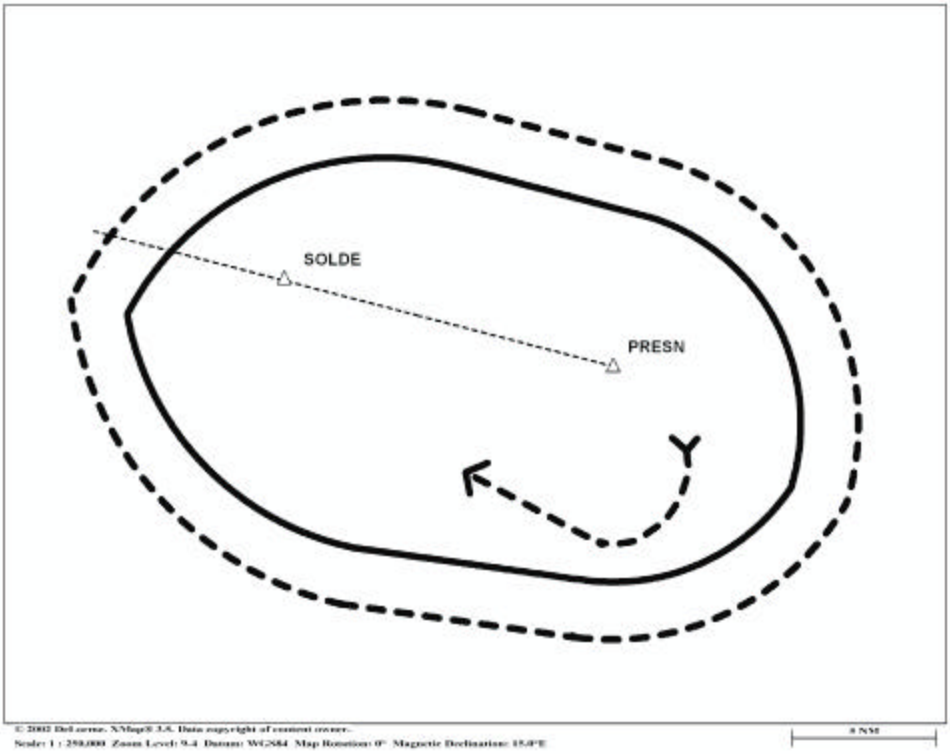

Figure 2 – Pattern Template 9

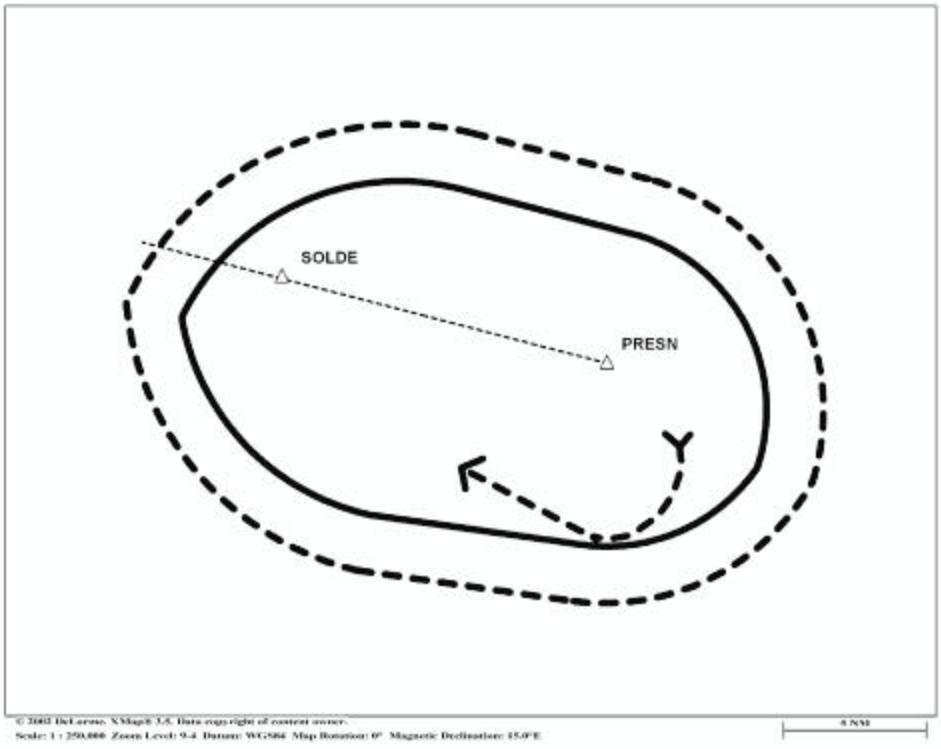

Figure 3 – Pattern Template 7

Parameters: Holding east of the facility/waypoint on the 270-degree (true) bearing, right-turns, 1-minute legs. 310 knots, IAS, 14,000 feet, ISA +15 degrees, Celsius. Wind from 180 degrees, true at 60 knots. Track shown is first turn subsequent to teardrop entry while wind correction is still being assessed.

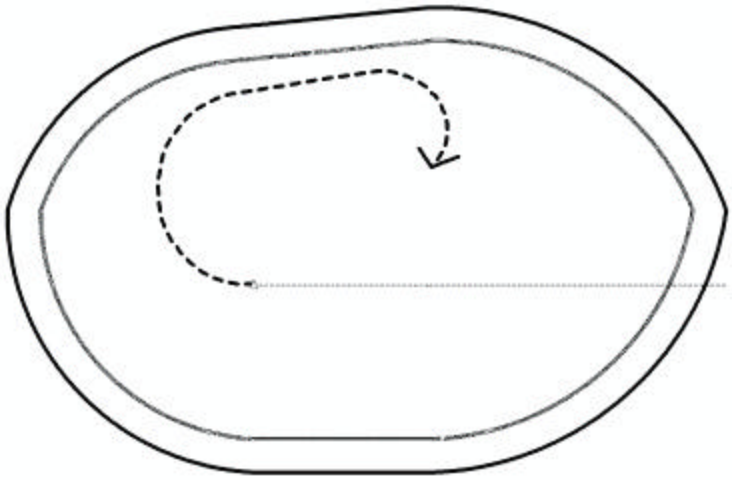

Figure 4 – Pattern Template 18

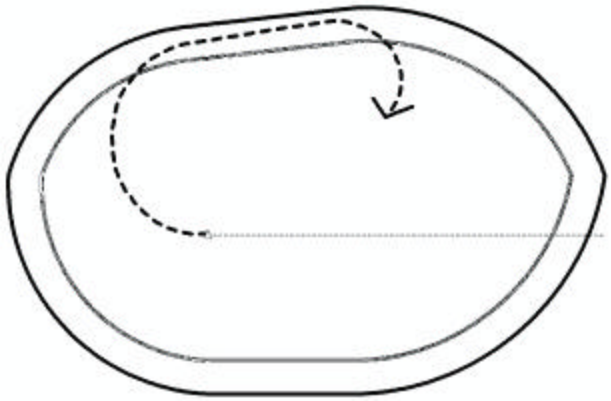

Figure 5 – Pattern Template 14

Conclusion: This evaluation validates the 1964 study and resultant holding pattern criteria for dead reckoning entry and outbound flight. It shows the 1997 “GPS” selection-process-reduction is invalid, as the flight parameters used are not extreme and thus should not result in departing the primary area and nearly departing the secondary area.

Initial Discussion - Meeting 03-01: New issue submitted by Wally Roberts, Aviation Consultant. The issue raises concern over the holding pattern size reduction for GPS holding verses the pattern size required for conventional NAVAID/fix holding. Wally is concerned that this reduction may have been subjective and rather than based on a full technical analysis. Bill Hammett, AFS-420 (ISI) briefed that the manager of AFS-420 has directed a full Airspace Simulation and Analysis for TERPS (ASAT) evaluation of GPS as well as helicopter/STOL holding pattern sizes. The results will be briefed to the ACF when complete. Bill recommended that the issue be re-titled "Holding Pattern Criteria Selection" as the climb-in-hold portion of the paper is being addressed under issue 02-01-241. The attachment relating to climb-in-hold will also be transferred to issue 02-01-241. Past experience has proven that issue papers that cover more than one topic often become confusing and become difficult to manage and resolve. The group agreed. ACTION: AFS-420.